

## Description of a new pest species of *Hemilecanium* Newstead (Hemiptera: Coccidae) on mango from Thailand, and a key to species of the genus

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### Abstract

The adult female and first-instar nymph of a new species of soft scale insect, *Hemilecanium mangiferae* Kondo & Williams **sp. nov.**, are described and illustrated. This species was collected on the trunk and branches of mango, *Mangifera indica* L., in Nakhon Pathom and Sukhothai Provinces, Thailand. The insect can cause serious damage by depleting the host sap and by producing large amounts of honeydew on which sooty molds grow. Damage was severe on the local mango cultivar, Nam DokMai. Also included are a revised diagnosis of the genus, a revised key to the adult females of the five species currently placed in the genus, and a key to the known first-instar nymphs.

### Resumen

La hembra adulta y la ninfa del primer estadio de una nueva especie de escama blanda, *Hemilecanium mangiferae* Kondo & Williams **sp. nov.**, se describe e ilustra. Esta especie fue colectada en el tronco y ramas del mango: *Mangifera indica* L. en las provincias de Nakhon Pathom y Sukhothai, Tailandia. Este insecto puede causar daños severos al mango privando al árbol de savia, y produciendo gran cantidad de melado cual induce el crecimiento de fumaginas. El daño fue más severo en un cultivar local conocido como Nam Dokmai. También se incluyen una diagnosis revisada para el género, una clave revisada para las hembras adultas de las cinco especies actualmente incluidas en el género, más una clave para las ninfas del primer estadio conocidas.

**Key words:** *Hemilecanium*, *Mangifera indica*, new species, soft scale, Thailand, keys, first-instars

### Introduction

The scale insect family Coccidae contains approximately 1,139 described species in 163

genera. In Thailand, 24 species of soft scales in 19 genera have been recorded (Ben-Dov *et al.* 2005).

In 1995, a soft scale insect was reported causing serious damage to mango trees in Sukhothai Province, Thailand. This insect was an undescribed species of *Hemilecanium* Newstead, a genus not previously recorded from Thailand. It is large when compared with most species in the family, and damages its mango host by depletion of sap and by producing large amounts of honeydew on which sooty molds grow. Heavy infestations of the insects can result in dieback of twigs and branches, and early flower and fruit drop.

Here we discuss the taxonomy of *Hemilecanium*, present a new generic diagnosis based on the adult female, and keys to both the adult females and known first-instar nymphs. The adult female and first-instar nymph of the new species are described and illustrated, and are compared with other species in the genus. Notes on the biology of pest species also are given.

## Materials and Methods

The new species was collected by the first author on the trunks and branches of mango (*Mangifera indica* L.) in Nakhorn Pathom Province, Thailand in September 1994 and May 1995. Also studied were specimens collected in Sukhotai Province by Mr. Futoshi Kawamura in April 1995. All specimens were slide mounted according to the method discussed by Kosztarab (1996) and studied under a ZEISS RA phase contrast compound microscope. Descriptions are based on multiple slide-mounted specimens. Illustrations follow the typical format for scale insects, with the dorsum shown on the left side, and the venter on the right side. Special features are enlarged to the side of each illustration. The terminology used to describe the adult female follows that of Hodgson (1994) except that we have replaced the term “microductule” by “microduct”, which is used more widely in the Coccidae and other families of Coccoidea (Kosztarab 1996; Williams 2004). The terminology for the first-instar nymph follows that of Miller (1991) and Williams (1997). The collecting data of the material studied are followed by the number of slides, with the total number of specimens, and the growth stage in parentheses. For example, one slide with three specimens, of which two are adult females and one second-instar male is represented as follows: 1(3: 2 adult females + 1 second-instar male). This is followed by the depositories in parentheses. Growth stages are not given when all specimens on the slide(s) are adult females.

## Specimen depositories

**AUCC:** Auburn University Coccoidea Collection, Auburn, Alabama, U.S.A.; **BME:** Bohart Museum of Entomology, University of California, Davis, U.S.A.; **BMNH:** The

Natural History Museum, London, U.K.; **SANC**: South African National Collection of Insects, Plant Protection Research Institute, Pretoria, South Africa; **USNM**: The National Entomological Collection of the National Museum of Natural History, Beltsville, Maryland, U.S.A.

### Material of other taxa studied for comparison

***Etiennea villiersi* Matile-Ferrero.** Paratypes: **SENEGAL**: Ziguinchor Region: Djibelor, 21-vii-1981, coll. J. Etienne, ex *Apharia senegalensis*, No. 8930-9&10: 2 (4: 4 first-instar nymphs) (MNHN).

***Hemilecanium imbricans* (Green).** **INDIA: Karnataka:** Mysore, 1945, coll. V. P. Rao, on *Sterculia alata* (Sterculiaceae), 11 (18: 7 adult females + 11 first-instar nymphs) (AUCC: AL-275-75, AL-074-95); **Karnataka:** Mysore, 7-viii-1905, coll. Maxwell-Lefroy, ex *Acrocarpus fraxinifolius* (Fabaceae), 2(2) (USNM); **Karnataka:** Mysore, date not given, specimens sent by E.E. Green, ex *Cedrus toona*, 2 (4: 2 adult females + 1 second-instar female + 1 first-instar nymph) (BME). **Maharashtra:** Bombay, 18-ix-1921, coll. J. C. Bridwell, ex *Phyllanthus* sp. (Euphorbiaceae), 2(2) (USNM).

***Hemilecanium coriaceum* Hall.** Holotype, paratypes: **ZIMBABWE:** Victoria Falls, 29-vii-1929, coll. W. J. Hall, ex undetermined plant, 5 (4: 1 specimen dorso-ventrally sliced and slide-mounted in two slides) (BMNH).

***Hemilecanium recurvatum* Newstead.** Holotype, paratypes: **D.R. CONGO (as ZAIRE):** Romee, near Stanleyville (currently Kisangani), 1945, coll. P. H. Kohll, ex *Plectronia laurentii* (Rubiaceae), 1(2) (BMNH).

***Hemilecanium theobromae* Newstead.** **SOUTH AFRICA: Transvaal:** Pretoria, Nelspruit, 19-vii-1977, coll. D. P. Annecke, ex *Euphorbia pulcherrina* (Euphorbiaceae), 31(13 adult females + 31 first-instar nymphs [28 slides AUCC: AL- (010, 013, 014)-2000, 3 slides (SANC)]), **ZIMBABWE (as RHODESIA): Harare (as Salisbury),** 3-v-1965, coll. M.E. Richardson, ex *Toona ciliata* (Meliaceae), 2(2) (BMNH).

### Taxonomy

#### ***Hemilecanium* Newstead**

*Hemilecanium* Newstead, 1906: 74 [*nomen nudum*] (Ben-Dov, 1993).

*Hemilecanium* Newstead, 1908: 39; Hodgson 1969a: 15, 1969b: 321; 1994: 278.

**Type species.** *Hemilecanium theobromae* Newstead, 1908, by original designation and monotypy.

The genus *Hemilecanium* was erected by Newstead (1908) for *Hemilecanium*

*theobromae* Newstead, collected from cacao (*Theobroma* sp.: Sterculiaceae) in Cameroon. The genus is represented in the Afrotropical and Oriental regions, and currently contains four species: *H. coriaceum* Hall, *H. imbricans* (Green), *H. recurvatum* Newstead and *H. theobromae* Newstead (Ben-Dov 1993). The genus was previously revised by Hodgson (1969b) to include three species: *H. imbricans* (Green), *H. theobromae* and *H. coriaceum*, but he did not mention *H. recurvatum*. Newstead (1910) apparently included *H. recurvatum* in *Hemilecanium* on the basis of the sclerotization and fusion of anal clefts, which are features shared with other species of *Hemilecanium*. However, unlike other *Hemilecanium* species, the anal plates on *H. recurvatum* are together pyriform, marginal spines are much fewer and separated from each other by a length of 3 or 4 spines, rather than being separated by less than one spine length. Furthermore, *H. recurvatum* has a pair of eyes and lacks dorsal submarginal tubercles. *H. recurvatum* does not belong in *Hemilecanium*, but further study is needed to properly place the species.

Hall (1935) tentatively placed *H. coriaceum* in the genus *Hemilecanium*, even though it lacked the four cribriform plates that are typical of the genus. He indicated similarities of *H. coriaceum* with *H. imbricans*, such as the marginal setae forming a fringe around the body margin, the presence of 10 setae on the anal ring and the presence of scattered glandular pores on the dorsal derm (restricted to the margins in *H. imbricans*). Hodgson (1969a, 1994) did not consider *H. coriaceum* to be congeneric, but did not place it in a different genus. *Hemilecanium coriaceum* fits the features found on *Etiennea* species, especially the type species *E. villiersi* Matile-Ferrero. *Hemilecanium coriaceum* and *E. villiersi* are similar in having dorsal tubercles with satellite tubular ducts in the outer sclerotized rim, in having one claw digitule wider than the other, and in lacking cribriform plates on the dorsum. Although adult females of *E. villiersi* and *Hemilecanium* species can be easily separated by the presence or absence of dorsal cribriform plates, the first-instar nymphs of *E. villiersi*, *H. imbricans*, *H. mangiferae*, and *H. theobromae* are very similar, including the lack of differentiated stigmatic spines, the presence of four dorsal cribriform plates, a single spiracular disc-pore associated with each spiracle, and one very long seta on the third antennal segment (Kondo unpublished data). Matile-Ferrero (1984) described the first-instar nymph of *E. villiersi* as follows: body margins surrounded by sharp spines; differentiated stigmatic spines and submarginal glandular tubercles absent; unusual presence of four circular areas, clearly delineated, and filled with quadrilocular pores, one pair dorso-thoracic and one pair dorso-abdominal; antennae 6-segmented; anal cleft present. In the adult female, the presence of a similar dorsal tubular duct with a funnel-like aperture in the adult females suggests *H. theobromae* and *E. villiersi* are closely related (Hodgson 1994). Studies using additional taxa, including species of other related genera, adult males and molecular techniques should help elucidate the relationship of *Hemilecanium* and *Etiennea* in the future.

The phylogenetic relationship of *Hemilecanium* within the Coccidae is also not well understood. Hodgson (1994) when redescribing the type species, *H. theobromae*, assigned

the genus to the Saissetiini (Coccinae), and suggested that *Hemilecanium* had more in common with the *Coccus*-group than with the *Eulecanium*-group, despite the adult females of *Hemilecanium* sharing several features with the latter group. His conclusion was based on a few features of the adult female (Hodgson 1994) and a morphological study of male specimens of *Etiennea petasus* Hodgson, which he considered to be closer to the *Coccus*-group than to the *Eulecanium*-group (Hodgson 1993).

We retain *H. recurvatum* and *H. coriaceum* in the genus until more information is available. Here we briefly rediagnose *Hemilecanium* Newstead *sensu stricto* based on those species possessing cribriform plates, namely *H. theobromae*, *H. imbricans* and *H. mangiferae*.

### Generic diagnosis of *Hemilecanium* Newstead *sensu stricto*

(based on adult females of *H. theobromae*, *H. imbricans* and *H. mangiferae*)

Dorsal derm membranous, areolated, becoming heavily sclerotized on mature specimens. Sclerotization on dorsum commencing on mid-dorsum, and/or around anal plates (Fig. 1A, B, C). Dorsal setae sharply spinose. Dorsum with 2 pairs of cribriform plates. Preopercular pores present. Dorsal tubular ducts with a funnel-like aperture present or absent. Dorsal microducts and simple pores present. Dorsal tubercles and pocket-like sclerotizations present submarginally. Anal plates together quadrate, located about 1/5 to 1/4 body length from posterior margin, each plate with 3 or 4 setae on dorsal surface. Eyes not detectable. Margins smooth, membranous or sclerotized. Marginal setae spinose, numerous, 59–147 between stigmatic clefts, width between each seta less than one setal length. Stigmatic clefts shallow or absent. Stigmatic spines not differentiated. Venter with a submarginal band of tubular ducts. Multilocular disc-pores each with 7–11 (mainly 10) loculi, present in vulvar region, and less abundant on abdominal segments and thorax. Multilocular disc-pores often present on area around coxae, mouthparts and antennae. Spiracular disc-pores each with 3–5 loculi, found around spiracles and extending onto body margin. Antennae well developed, 8 or 9 segmented. Legs well developed, without tibio-tarsal scleroses; claw with a small denticle. Spiracles located closer to legs than to body margin.

### Key to the species of adult females of *Hemilecanium* Newstead *sensu lato*

1. Eyespots present; anal plates together pyriform ..... *H. recurvatum* Newstead
- Eyespots absent; anal plates together quadrate (Fig. 3I) ..... 2
2. Cribriform plates absent ..... *H. coriaceum* Hall
- Cribriform plates present (Fig. 3C) ..... 3
3. Dorsal tubular ducts present, each with a sclerotized funnel-shaped aperture .....  
..... *H. theobromae* Newstead

- Dorsal tubular ducts absent ..... 4
- 4. Derm sclerotization pronounced on mid-dorsum (Fig. 1A); submarginal dorsal tubercles numbering 41 to 66 ..... *H. imbricans* (Green)
- Derm sclerotization pronounced around anal plates (Fig. 1D); submarginal dorsal tubercles numbering 18–24 ..... *H. mangiferae* sp. nov.

#### Key to separate the known first-instar nymphs of *Hemilecanium* species

- 1. Marginal setae slender, with a flagellate apex ..... *H. theobromae* Hall
- Marginal setae slender or sharply spinose, straight or slightly bent, without a flagellate apex ..... 2
- 2. Anterior cribriform plates each with 18–25 pores; posterior cribriform plates each with 21–30 pores; marginal setae 15–35  $\mu$ m long, gradually becoming longer towards anal lobes, longest setae on anal lobes 35  $\mu$ m long ..... *H. mangiferae* sp. nov.
- Anterior cribriform plates each with 30–48 pores; posterior cribriform plates each with 34–55 pores; marginal setae 39–57  $\mu$ m long, setae becoming gradually longer towards anal lobes, but posterior 1 or 2 setae on anal lobes up to 100  $\mu$ m long .....  
..... *H. imbricans* (Green)

#### *Hemilecanium mangiferae*, new species

**Material studied:** Holotype, adult female. **THAILAND: Sukhothai Province:** Sawankhalok, 26-iv-1995, coll. F. Kawamura, ex *Mangifera indica*, 1(1) (USNM).

**Paratypes:** **THAILAND:** same data as holotype 5(5) (USNM), 5(5) (BMNH); **Nakhon Pathom Province:** Kamphaengsaen, Kasetsart University, 13-v-1995, coll. T. Kondo, ex *Mangifera indica*, 24 (34: 2 adult females + 32 first-instar nymphs) (AUCC: AL-077-2000).

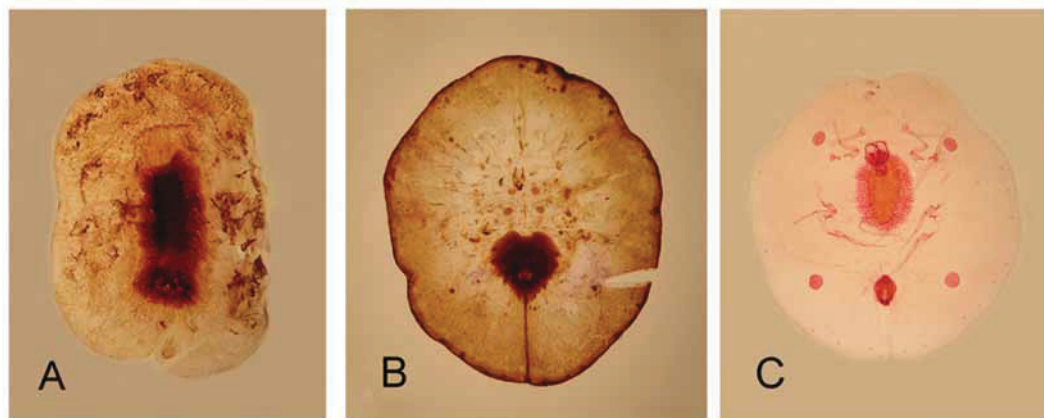
**Diagnosis.** Slide-mounted adult females of *H. mangiferae* can be easily separated from similar stages of other *Hemilecanium* species currently included in the genus by the following combination of features: (i) presence of two pairs of cribriform plates on the dorsum; (ii) submarginal dorsal tubercles numbering between 18–24; a (iii) presence of a large dorsal sclerotization around anal plates, rather than medially on dorsum; and (iv) absence of dorsal tubular ducts with a sclerotized funnel-shape aperture.

**Description of adult female** (n=13) (Figs. 1B, 2A, B & D & 3).

**Unmounted material.** Living adult females (Figs. 2A & B) subcircular, slightly convex, becoming somewhat asymmetrical when overcrowded. Insects large, 8–15 mm wide, young adult females gray to brown in color, with marginal waxy filaments present (Figs. 2A & 3Q). Older specimens darker in color, usually with marginal waxy filaments broken off (Fig. 2B). Position of cribriform plates on slide mounted specimens sometimes



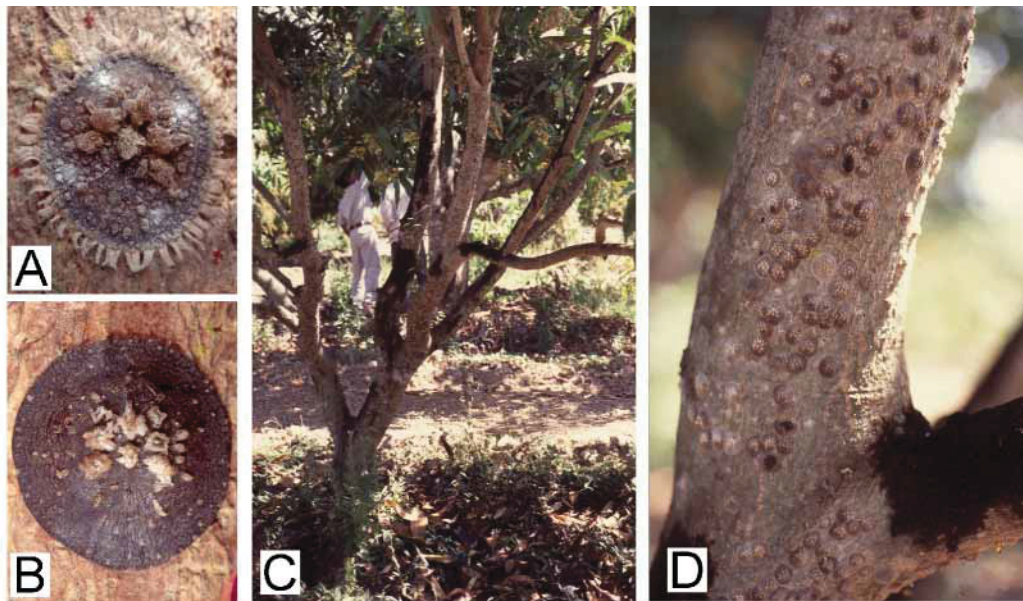
recognizable as 4 white powdery spots on living insect. Mature adults develop 6 clumps of waxy secretions on central area of dorsum (Fig. 2A, B & 3Q).



**FIGURE 1.** A, adult female *Hemilecanium imbricans*: typical dorsal sclerotization pattern on mid-dorsum and anal plates; B, adult female *H. mangiferae* **sp. nov.**: typical sclerotization pattern restricted to around anal plates; C, adult female *H. theobromae*: typical sclerotization pattern restricted to mid-dorsum.

**Mounted Material.** Body circular to subcircular, length 5–12 mm, width 3.8–11 mm. Stigmatic clefts absent; anal cleft fused, about 1/3 body length.

**Dorsum:** Derm strongly sclerotized in older specimens. Simple pores (Fig. 3E) each 2  $\mu$ m wide, scattered evenly throughout dorsum. Dorsal microducts (Fig. 3G) each 3  $\mu$ m wide, scattered throughout dorsum and forming a band along body margin near marginal setae. Dorsal setae (Fig. 3H) sharply spinose, each 10–25  $\mu$ m long, straight or slightly bent. Submarginal dorsal tubercles (Fig. 3A) numbering 18–24 around body; large, each 21–25  $\mu$ m wide, some difficult to detect due to sclerotization of margin. Pocket-like sclerotizations (Fig. 3B) found occasionally just mesad to submarginal tubercles. Preopercular pores (Fig. 3F) conical, small, each 4–6  $\mu$ m wide, usually not visible due to density of sclerotization around anal plates. Cribriform plates 4 in number: 1 pair in head region and 1 pair on abdomen, each plate oval to round, 110–230  $\mu$ m wide, with 200 or more 5-locular disc-pores (Fig. 3C). Dorsal tubular ducts absent. On young adult females, sclerotization begins from area surrounding anal plates (Figs. 1B & 3I) and body margin (Fig. 1B). On older specimens, 6 additional areas of sclerotization appear mid-dorsally, corresponding to areas where clumps of wax material occur on living insects. Anal plates (Fig. 3J) together quadrate, heavily sclerotized, with outer angles rounded; each plate 280–310  $\mu$ m long, 110–140  $\mu$ m wide, with 3 or 4 dorsal setae near apex and 3 lateral margin setae ventrally. Anal fold with 10 anterior margin setae.

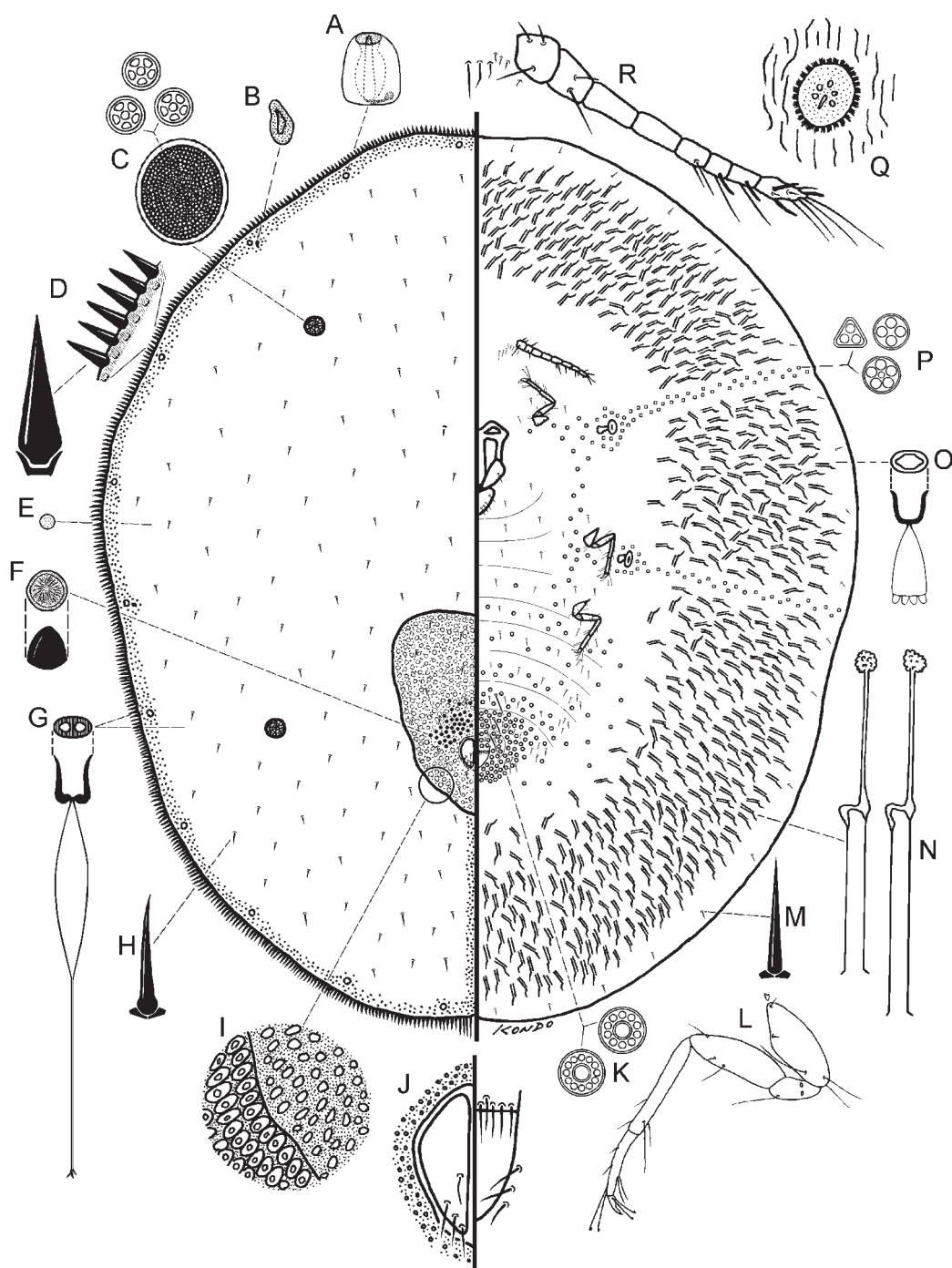


**FIGURE 2.** A, adult female *Hemilecanium mangiferae* sp. nov. Note clumps of dorsal waxy secretions and marginal waxy secretions; B, old adult female *H. mangiferae* sp. nov. Note darker coloration and lack of marginal waxy secretions; C, ground just below heavily infested tree darkened by sooty mold; D, surface of branches of mango tree covered with *H. mangiferae* sp. nov. Note sooty mold growing on accumulated honeydew on lower branch. (Photographs C & D by F. Kawamura).

*Margin:* Marginal setae spinose (Fig. 3D), similar to dorsal setae but stouter and straight; each 36–47  $\mu\text{m}$  long, numerous, with 82–147 between stigmatic clefts; usually with 3 or 4 longer marginal setae on each anal lobe, each 53–82  $\mu\text{m}$  long. Stigmatic clefts absent; stigmatic spines not differentiated from marginal spines. Eyespots not detected.

*Venter:* Derm membranous. Antennae 8 or 9 segmented (Fig. 3R), total length 528–674  $\mu\text{m}$  long. Ventral setae (Fig. 3M) slender, shorter than dorsal setae, 7–12  $\mu\text{m}$  long; with 4–7 pairs of interantennal setae. Clypeolabral shield 291–377  $\mu\text{m}$  wide. Multilocular disc-pores (Fig. 3K) 7–11 (mostly 10) locular and 6.4–8.5  $\mu\text{m}$  wide; numerous around genital opening, extending onto area near prothoracic legs and anterior spiracles, and with a few anterior to antennae; those furthest from pregenital area each 7–10 locular. Tubular ducts (Fig. 3N) in a submarginal band, those found more medially usually longer than those near margins. Ventral microducts (Fig. 3O) large, each 3.4–3.6  $\mu\text{m}$  wide, found throughout venter. Spiracles rather large, anterior peritreme 108–135  $\mu\text{m}$  wide, posterior peritreme 108–138  $\mu\text{m}$  wide. Spiracular disc-pores (Fig. 3P) each with 3–5 loculi, and 4.3–6.4  $\mu\text{m}$  wide; in a narrow band, each band broadening near spiracular peritreme; bands not always reaching body margin. Legs well developed, without tibio-tarsal articulatory scleroses; tarsal digitules knobbed, of equal size, longer than claw digitules (Fig. 3L). Claw digitules knobbed, of equal length, one slightly thicker than other. Claw denticle present. Trochanter plus femur 243–350  $\mu\text{m}$  long, tibia plus tarsus 318–430  $\mu\text{m}$  long.



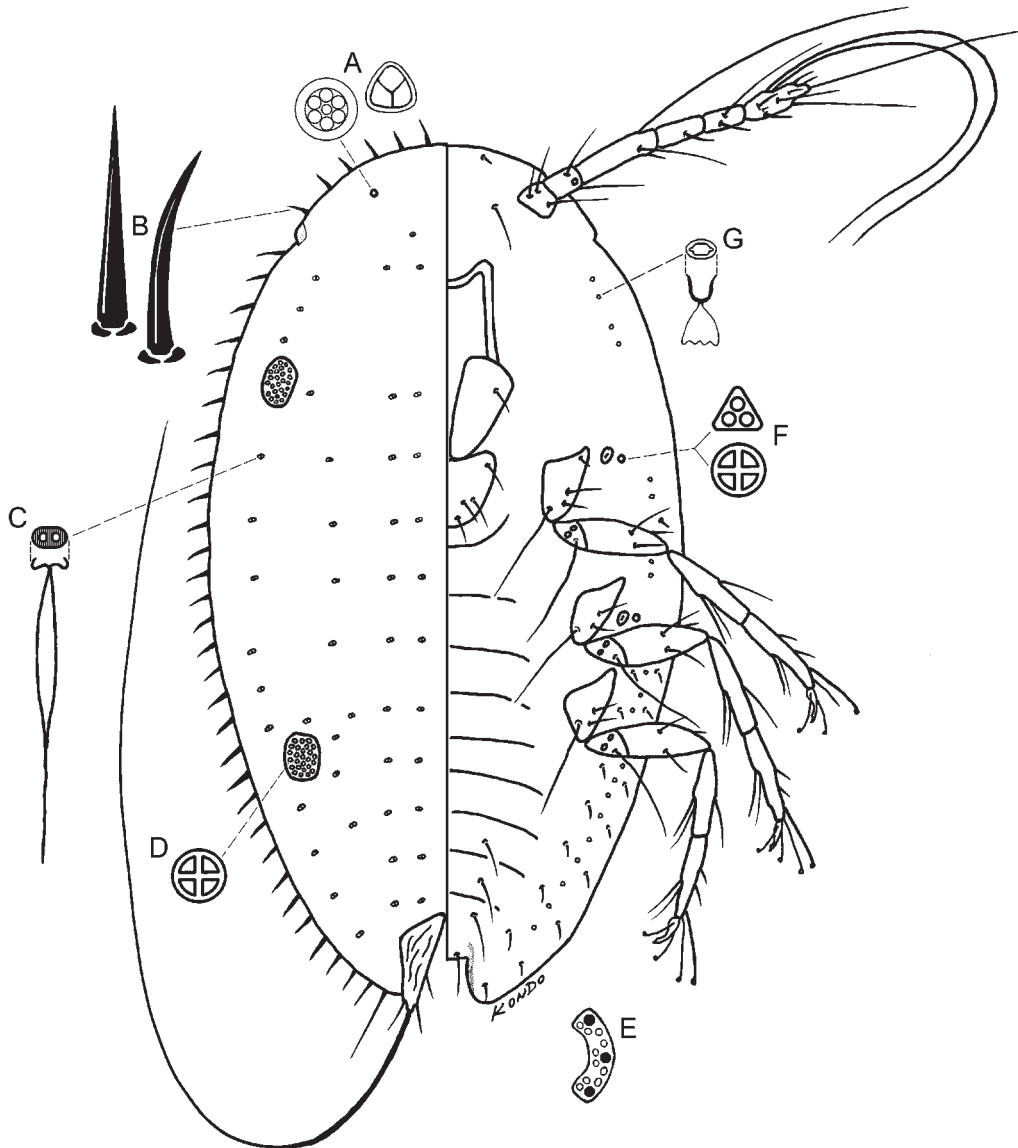


**FIGURE 3.** *Hemilecanium mangiferae* sp. nov., adult female. Where (A) submarginal dorsal tubercle; (B) pocket-like sclerotization; (C) 5-locular disc-pores in cribriform plate; (D) marginal setae; (E) simple pore; (F) preopercular pore; (G) dorsal microduct; (H) dorsal setae; (I) dorsal derm; (J) anal plates; (K) pregenital disc-pores; (L) metathoracic leg; (M) ventral seta; (N) tubular ducts; (O) ventral microduct; (P) spiracular disc-pores; (Q) scale insect in situ; (R) antenna.

**Description of first-instar nymph (n=32) (Fig. 4)**

**Unmounted material.** Newly-eclosed nymph reddish brown in color; dorsum with 2 pairs of white spots, one pair on head and other pair on abdominal region, both pairs near body margin.

**Mounted material.** Body elongate oval, widest across metathoracic region. Length 512–561  $\mu\text{m}$ , width 270–334  $\mu\text{m}$ . Stigmatic clefts lacking; anal cleft shallow.



**FIGURE 4.** *Hemilecanium mangiferae* sp. nov., first-instar nymph. Where (A) 3- & 6-locular pores; (B) marginal setae; (C) microduct; (D) 4-locular pore of cribriform plate; (E) anal ring; (F) spiracular disc-pores; (G) ventral microduct.

**Dorsum:** Derm membranous throughout and smooth. Dorsal setae absent. One pair of circular disc-pores located at apex of head, either 3 or 6 locular (Fig. 4A). Numerous small microducts (Fig. 4C), each 1.8  $\mu\text{m}$  wide and appearing bilocular, present submedially and submarginally from head toward apical region. Two pairs of submarginal cribriform plates present, each 30–48  $\mu\text{m}$  wide, anterior pair on head each with 21–30 pores, posterior pair each with 18–25 pores. Pores in cribriform plates each 4-locular (Fig. 4D). Anal plates mildly sclerotized, each 64–75  $\mu\text{m}$  long, 22–28  $\mu\text{m}$  wide. Each plate with 4 dorsal setae: 1 on mesal margin and 3 apical. Median apical seta as long as body length. Each plate with 1 ventral subapical seta. Anal fold with 1 pair of anterior margin setae. Anal ring (Fig. 4E) hexagonal-oval with rounded angles; with a row of irregularly shaped pores and 6 anal ring setae.

**Margin:** Margins slightly sclerotized. Marginal setae spinose (Fig. 4B), each 12–34  $\mu\text{m}$  long, becoming longer and more setose near anal lobes, each often slightly curved; with 65–86 setae around body, and with about 6 marginal setae between stigmatic areas. Stigmatic clefts absent; stigmatic spines not differentiated from marginal setae. Eyespots present on margin just below level of antennal scape.

**Venter:** Derm membranous, rugose; margins mildly sclerotized. Spiracles small, round or oval in shape; peritremes each 9  $\mu\text{m}$  wide. Spiracular disc-pores each 2–4 locular (Fig. 4F) and 3–4  $\mu\text{m}$  wide; with 1 pore associated with each spiracle. Submarginal setae each 4–10  $\mu\text{m}$  long; in 2 longitudinal rows on each side of abdomen between posterior spiracle and anal cleft, 8 setae in outer row, and 7 setae in inner row, 1 seta between each lateral stigmatic areas, and 1 pair near apex of head; setae next to margins shorter. Three pairs of ventral submedian setae on posterior abdominal segments, each 20–50  $\mu\text{m}$ ; and 1 pair of interantennal setae between antennal scapes, each 45–55  $\mu\text{m}$  long. Ventral microducts (Fig. 4G) present submarginally, each 1.8  $\mu\text{m}$  wide, with 2 pairs between antennal base and each anterior spiracle, 2 pairs between spiracles, and 12 between inner and outer submarginal setae on each side of body in abdominal region. Legs well developed, with separate tibia and tarsus, without tibio-tarsal scleroses; claw with a small denticle. Tarsal digitules subequal in length and longer than claw digitules, latter also subequal in length. Dimensions: trochanter + femur 79–90  $\mu\text{m}$  long, tibia + tarsus 115–135  $\mu\text{m}$  long. Antennae 6 segmented, 194–213  $\mu\text{m}$  long, each with an extremely long seta on 3rd and 6th antennal segments. Clypeolabral shield, 94–106  $\mu\text{m}$  wide.

**Etymology.** This species is named after its host: mango (*Mangifera indica* L.).

**Biology.** The first author found *Hemilecanium mangiferae* in low numbers in Nakhorn Pathom Province, where it appeared to be controlled by a species of parasitoid wasp since many specimens had several exit holes in their dorsum. The soft scales were occasionally visited by the Asian weaver ant, *Oecophylla smaragdina* Smith, which might protect them against natural enemies whilst collecting their honeydew. However, the symbiotic relation between *H. mangiferae* and the weaver ants appears facultative, as weaver ants preferred honeydew-producing scale insects that fed on the foliage where the ants build their aerial

nest. During the present study in Thailand, the arboreal nests of *O. smaragdina* built on mango trees were always found harboring coccoids, particularly *Coccus hesperidum* L. (Coccidae), and less commonly *Rastrococcus spinosus* (Robinson) (Pseudococcidae) and *Icerya seychellarum* (Westwood) (Margarodidae) (T. Kondo, personal observation).

In a separate field study of pests of mango conducted by Mr. Futoshi Kawamura in 1995 in five Provinces of Thailand (Bangkok, Chachoengsao, Chiang Mai, Songkhla and Sukhothai), *H. mangiferae* was found only in Sukhothai Province, in an orchard located in Sawankhalok District. In that orchard, *H. mangiferae* was reported causing serious infestations during April associated with sooty mold, especially on the native mango cultivar "Nam Dokmai". On some trees, the surface of the twigs and branches was completely covered by these insects (Figs. C&D). Large amounts of sooty mold were growing on the honeydew, blackening the ground just below the infested canopy (Fig. 2C), and also the trunk, branches and twigs (Fig. 2C, D). Furthermore, the leaves of the infested trees showed signs of yellowing. According to the owner of the orchard, in the 20 years of growing mangoes, the scale insect had been noticed only in the one or two years previous to the outbreak, and chemical treatment had had little effect on the insects. Therefore, control had been attempted by brushing the insects off the bark (F. Kawamura, personal communication).

### Acknowledgements

We are very grateful to the following people: J.H. Martin, BMNH, London, and to I. Millar, SANC, Pretoria, for loan of material; to F. Kawamura for donating the type specimens and photos; to D. R. Miller of the USNM, Maryland, for the loan of material, for reviewing the early stages of the manuscript and for his critical advice on the drawings; P.J. Gullan for commenting on a draft of the manuscript; B. Sayampol for supporting the research of the first author in Thailand; to C.J. Hodgson and Douglas J. Williams for reviewing the manuscript. This work was supported in part by the National Science Foundation under Grant No. 0118718 to P.J. Gullan.

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